IAG Young Authors Award 2015
Citation for Xingxing Li

The IAG Young Authors Award 2015 is presented to Dr. *Xingxing Li* for his paper *Accuracy and reliability of multi-GNSS real-time precise positioning: GPS, GLONASS, BeiDou, and Galileo*. The work was published in the Journal of Geodesy, 2015, Volume 89, Issue 6, pp.607-635.

The lead author, Dr. *Xingxing Li*, has focused on high-precision GNSS and Geosciences' applications for more than ten years. He started his Geodesy studies at Wuhan University in 2004. In 2010, he was hired by the German Research Center for Geosciences (GFZ) as a project scientist for the project "Online-GNSS service with scalable accuracy for precise positioning and navigation". In 2015, he defended his doctoral thesis on "Real-time high rate GNSS techniques for earthquake monitoring and early warning" at Technische Universität Berlin.

He has already received several awards. In 2012, he won the ION paper Award and he won the GFZ "Friedrich-Robert-Helmert" Award in 2016. In 2017, he won the EGU Outstanding Young Scientist Award. Dr. Li has an excellent publication record with more than 30 papers in leading ISI journals of his research field during this period and in majority as first author. Currently, he is the Chair of the IAG working group "Biases in Multi-GNSS data processing" and the co-Chair of the EGU session "High-Precision GNSS Algorithms and Applications in Geosciences".

The award-winning paper presents a four-system integrated model with GPS, GLONASS, BeiDou and Galileo for real-time precise orbit determination, clock estimation and positioning. Meanwhile, an efficient multi-GNSS real-time precise positioning service system is designed and demonstrated. A rigorous multi-GNSS analysis is performed to achieve the best possible consistency by processing the observations from different GNSS together in one common parameter estimation procedure. For satellite orbit, the overlap (two adjacent three-day solutions) RMS values of estimated Galileo orbits are 2.1, 3.7 and 7.8 cm, respectively in radial, cross and along components. The corresponding overlap RMS values for BeiDou IGSO satellites are 2.5, 3.3, and 4.4 cm in the three components, respectively. The RMS values of BeiDou MEO satellites are 3.4, 4.3 and 11.3 cm in the radial, cross, and along directions, respectively.

The GEO satellites have comparable performance compared with IGSO and MEO satellites in the radial and cross directions, but the accuracy in the along component decreases to about 1 m due to the rather weak geometry. For satellite clock, the RMS values of clock differences between the real-time and batch-processed solutions for GPS satellites are about 0.10 ns, while the RMS values of BeiDou, Galileo and GLONASS satellites are 0.13, 0.13 and 0.14 ns, respectively. Both satellite orbits and clocks can achieve an accuracy of cm level in real time. It is worth noting that the errors of orbits and clocks can be compensated by each other when they are used together at user end. For precise point positioning (PPP), it can be used to validate the capability of real-time precise positioning service based on the predicted orbits and real-time estimated clocks.

The multi-GNSS PPP shows faster convergence and higher accuracy in all three components than single-system PPP. After adding BeiDou, Galileo and GLONASS systems to the standard GPS-only processing, the convergence time is decreased by 70 % and the positioning accuracy is improved by 25 %. The real-time positioning capabilities of the combined systems under different elevation cutoffs is different. Its positioning accuracy hardly decreases and an accuracy of several centimeters is still achievable in horizontal components even with a 40° elevation cutoff. At 30° and 40° elevation cutoffs, the availability rates of GPS-only solutions drop dramatically to only around 70 and 40%, respectively. However, multi-GNSS PPP shows excellent results.

In a word, the fusion of multiple GNSS significantly increases the number of observed satellites, optimizes the spatial observation geometry at a site and improves convergence, accuracy, continuity and reliability of positioning solutions. Moreover, the performance of multi-GNSS integration at high elevation cutoffs will significantly increase its applications in constrained environments, such as in urban canyons, open pits and mountainous areas.

IAG Young Authors Award 2016 Citation for Olga Didova

The IAG Young Author Award 2016 is given to *Olga Didova* for her paper *An approach for estimating time-variable rates from geodetic time series*, which has been published in the Journal of Geodesy (2016) 90:1207-1221. The paper is co-authored by *Brian Gunter*, *Riccardo Riva*, *Roland Klees*, and *Lutz Roese-Koerner* representing 3 different scientific institutions.

The original article considers the problem of estimating trends in mass loss over Antarctica from GRACE and GPS time series in the presence of inter-annual and seasonal variability. The traditional approach parameterizes the time series using a bias, trend, and harmonic constituents, which are considered as being deterministic. The main weakness of this approach is that the distinct components of mass loss (as those of many other geophysical processes) are not deterministic, but fluctuate in time around some reference values.

The idea to model them stochastically using a state space model and estimating the state parameters using a Kalman filter was introduced to the geodetic community in a paper by Davis et al (2012), though state space analysis is a well-established methodology for treating a wide range of problems in the analysis of econometric time series as documented in the excellent books by Harvey (1989) and Durbin and Koopman (2012). Davis et al (2012) assumed that the parameters, which determine the stochastic movements of the state variables ("hyperparameters"), are known. Moreover, little is known in econometric literature about the robust estimation of hyperparameters, which is a non-convex optimization problem.

In her paper, Olga considers the hyperparameters as unknowns and estimates them using Maximum Likelihood. The optimization problem is solved using a gradient-based local solver, which can deal with non-convex problems. To increase the probability of finding the global minimum, Olga suggests to define a random set of uniformly distributed starting values and selects the starting values that provides a solution which has the smallest log likelihood objective function. To improve the chance of finding the global minimum, Olga suggests several measures to limit the parameter search space. Moreover, she introduces inequality constraints on some of the hyperparameters, and suggests a method, involving among others a likelihood ratio test and an algorithm for determining the degrees of freedom for this test, to verify whether the constraints are supported by the data.

The suggested methodology is applied to the analysis of real GRACE and GPS time series, both representing vertical deformations due to elastic and visco-elastic responses of the solid Earth to surface loading. The data analysis reveals that compared to the classical deterministic model using least-squares, the proposed methodology provides more reliable trend estimates, because it accounts for any long-term evolution in the time series and avoids any contamination from seasonal variability.

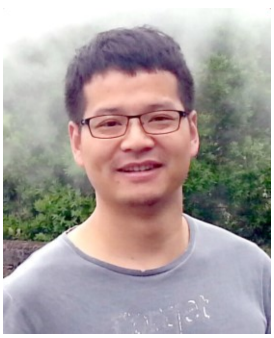
The proposed methodology may become a standard tool in time series analysis of geodetic data, in particular when long time series comprising years of data are involved.

Olga Didova studied Geodesy and Geoinformation at the University of Bonn, Germany. She received her Bachelor of Science in 2009 and her Master of Science in 2011 under supervision of *Karl Heinz Ilk* and *Juergen Kusche*, respectively. Between 2012 and 2016, she was a PhD candidate at Delft University of Technology in the Department of Geoscience and Remote Sensing working on "Separating GIA and ice mass change signals in Antarctica using satellite data". She will defend her PhD thesis at Delft University of Technology in fall 2017. Since March 2017, she is a Postdoctoral Fellow at the University of Bonn and involved in the assimilation of remote sensing data in a hydrological model.

References:

JL Davis, BP Wernicke, ME Tamisiea (2012), On seasonal signals in geodetic time series. J Geophys Res 117(B01403).
AC Harvey (1989), Forecasting, structural time series models and the Kalman filter. Cambridge University Press, Cambridge.
J Durbin, SJ Koopman (2012), Time series analysis by state space methods. Oxford University Press, Oxford.

Young Authors Award 2017
Citation for Minghui Xu



The IAG Young Authors Award 2017 is presented to Dr. Minghui Xu for his paper *The impacts of source structure on geodetic parameters demonstrated by the radio source 3C371*. The work was published in the Journal of Geodesy, 2017, Volume 91, pp.767-781.

The leading author, Dr. *Minghui Xu*, has focused on high-precision very long baseline interferomery (VLBI) studies for ten years. He started his Geodesy studies in Shanghai Astronomical Observatory (SHAO) in 2009. In 2013, he got the German DAAD scholarship to join the German Research Center for Geosciences (GFZ) VLBI group for his PhD. He defensed his doctoral thesis on *Determining the acceleration of Solar System's Barycenter by VLBI* at SHAO in 2015. He was awarded as a Mercator Fellow in Germany in 2017. Currently, he is the research fellow in Aalto University Metsahovi Observtory and is working on mitigating source structure effects on broadband VLBI (VGOS) observations in order to achieve the goal of VGOS, the mm accuracy of station positions on global scales.

The award-winning paper investigates closure quantities measured by very-long-baseline interferometry (VLBI) observations that are independent of instrumental and propagation instabilities and antenna gain factors, but are sensitive to source structure. A new method is proposed to calculate a structure index based on the median values of closure quantities rather than the brightness distribution of a source. The results are comparable to structure indices based on imaging observations at other epochs and demonstrate the flexibility of deriving structure indices from exactly the same observations as used for geodetic analysis and without imaging analysis.

A three-component model for the structure of source 3C371 is developed by model-fitting closure phases. It provides a real case of tracing how the structure effect identified by closure phases in the same observations as the delay observables affects the geodetic analysis, and investigating which geodetic parameters are corrupted to what extent by the structure effect. Using the resulting structure correction based on the three-component model of source 3C371, two solutions, with and without correcting the structure effect, are made. With corrections, the overall rms of this source is reduced by 1 ps, and the impacts of the structure effect introduced by this single source are up to 1.4 mm on station positions and up to 4.4 microarcseconds on Earth orientation parameters. This study is considered as a starting point for handling the source structure effect on geodetic VLBI from geodetic sessions themselves.

Young Authors Award 2018
Citation for Athina Peidou

Granted for the article*: On the feasibility of using satellite gravity observations for detecting large-scale solid mass transfer events*, Journal of Geodesy, Vol. 92, pages 517-528 by *Athina Peidou*, *Georgia Fotopoulos* and *Spiros Pagiatakis*. The focus of the paper is to assess the feasibility of using dedicated satellite gravity missions (specifically GRACE) to detect large-scale solid mass transfer events (e.g. landslides).

Dr. *Athina Peidou* holds an undergraduate degree from the School of Rural and Surveying Engineering at Aristotle University of Thessaloniki graduating at the top of her class. She pursued Master's studies in the Geophysics and Geodesy Lab of the Department of Geological Sciences and Geological Engineering at Queen's University, Kingston, Canada. For her PhD studies, Athina joined Prof *Spiros Pagiatakis's* Space Geodesy Lab in the Department of Earth and Space Science and Engineering at York University, Toronto, Canada. She defended her doctoral thesis in 2020 which was awarded with Canada's General Governor's Gold Medal. Recently, she joined NASA's Jet Propulsion Laboratory as a postdoctoral research fellow to work on GRACE and GRACE-FO missions.

The main objective of the award-winning paper was to determine the feasibility of detecting landslides and earthquakes using models derived from GRACE mission measurements. This was assessed through a sensitivity analysis of GRACE- gravity field solutions in conjunction with simulated case studies of large-scale solid mass transfers. The simulations focused on determining the effect of various-scale geohazards on the gravity field as measured by GRACE, and this was achieved by means of 3-D forward modelling and 2-D wavelet multi-resolution analysis. Real events studied include catchment-scale events such as the Heart Mountain Landslide (50km x 70km) and the Tohoku earthquake triggered submarine landslide (40km x 20km) as well as regional scale events such as the Agulhas slump (750km x 106 km) and the Grand Banks slide (1000km x 25km). Results indicate the spatial extent (and volume) of mass transfer events that can be detected using GRACE measurements. Additionally, the study proceeds with sensitivity analysis of the impact of the altitude of the satellite on the resolvability of a mass transfer, assuming an inherent noise level of approximately 30 microgals (this includes satellite noise and aliasing effects). Overall, this study improves our understanding on mass movement processes and their direct impact on the gravity field as mapped by the dedicated missions.

Due to limited information on oceanic environments, most submarine landslides remain unknown while the detrimental effects of landslides on societies are often documented in the news. With satellite gravity measurements being continuously available, detection of submarine events could be feasible; therefore this research constitutes an important contribution towards detecting the Earth's dynamic processes in submarine environments.